A213

PATENT SPECIFICATION

674,082

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COMPLETE SPECIFICATION.

Improvements in or relating to the Underground Gasification of Coal.

We, NATIONAL RESEARCH DEVELOPMENT CORPORATION, a British Corporation, established by Statute, of 1, Tilney Street, London, W.1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the underground gasification of coal.

In the known systems for the underground gasification of coal, a stream of gasifying medium, such as air or mixtures of air with oxygen and/or steam or a mixture of steam and oxygen, is passed through a suitable channel in the coal seam, for example black or brown coal or lignite. It has been found that in such systems the calorific value of the gas obtained is lower than has been anticipated and that in certain cases the oxygen finds its way in the elemental state through the gasification zone and appears in the effluent gas. The presence of such oxygen in the final gas is a clear indication that contact between the coal and the gasifying medium is not as satisfactory as desirable and this is supported by the low calorific value of the gas generally obtained which results from low gasification temperatures due to the same absence of efficient contact, coupled with partial combustion of the gas formed by oxygen which is finding its way through the gasification zone.

This disadvantage is obviated according to the present invention by the provision of means so situated in proximity to the gasification zone as to impart a swirling motion to the stream of gasifying medium so that closer contact between the stream and the coal face is obtained at the point of gasification.

The invention is illustrated diagrammatically in the drawing accompanying the Provisional Specification in which Figure 1 represents a complete underground gasification system and Figure 2 represents the means for imparting a swirling motion to the gaseous stream.

Referring to the drawings, the coal A is undergoing gasification in the passage B through which a gasifying medium is conducted through the inlet pipe C to the outlet pipe D. At the point E in the passage B immediately adjacent to the lower end of the inlet pipe is situated the swirler shown in Figure 2. The swirler comprises a number of vanes F arranged radially in a housing G, the vanes being set at a suitable angle to impart the necessary swirl to the gases.

The form of swirler illustrated in Figure 2 is given merely by way of example, and other forms such as suitably designed nozzle passages, mechanical paddles, etc., may be employed if desired.

The form of swirl designed to produce more intimate contact between the gaseous stream and the coal face may be a simple single core vortex or composed of several vortices with their axes of rotation lying in the direction of the gas stream.

For efficient contact, each molecule of reacting gas in the gasifying medium must be brought into close proximity with the fuel constituting the walls of the passage and at the same time reacted gases in the boundary layer should be removed. Such conditions might be achieved by employing a highly turbulent state in the reacting gases i.e. a very high Reynolds number. Such a highly turbulent state, however, results in a high pressure drop and necessitates a length/diameter ratio for the passage to be about 500 or more. In the present invention, the desired contact is achieved by operating at

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Reynolds numbers, based on the effective hydraulic diameter of the gas passage, up to 15,000 i.e. broadly in the range just above streamline flow. Imposed upon the main flow is a swirling motion (or motions) arranged so that the axis of rotation is in the same direction as that of the gas passage through the coal.

The imposing of a swirling motion on the gaseous flow, in accordance with the invention has the following advantages:—

(1) The gas molecules are caused to traverse a spiral path with the result that they are retained longer (for a given local gas velocity) in a given length of passage i.e. the maximum effect is achieved for a given length to effective diameter ratio of the passage.

(2) The inevitable decay of swirl takes place due to wall friction, leads to longitudinal pressure gradients in the air passage; these gradients lie in the same direction as the stream along the walls of the passage but against the stream at the core of the passage. The result is that the profile of velocity in the direction of the passage is more favourable than for swirl-free flow in that the velocity is high near the walls and decelerated in the core. The tendency for unreacted gas to pass untouched through the centre parts of the passage is therefore checked. Indeed this effect may be exploited where desirable to produce an actual flow reversal near the centre of the passage so that incompletely reacted products may be returned, in part, for further contact with the walls of the passage.

(3) The centrifugal gradient of pressure maintained outwards by the swirl will prevent unreacted gas striking through at sudden enlargements of the passage area since the swirl maintains close contact of the high velocity stream with the rapidly diverging walls.

(4) The net result of these effects is that the length of passage required for effective gasification is greatly reduced, hence total heat losses by conduction to the surrounding rock and coal are diminished and higher temperatures result in the reaction zone giving rise to gas of higher calorific value.

(5) All the advantages which the swirl has in bringing gas molecules into contact with the coal apply equally to the distribution of heat by heat transfer throughout the reaction zone.

What we claim is:—

1. In a system for the underground gasification of coal in which a stream of gasifying medium (such as air, or air mixed with oxygen, or a mixture of steam and oxygen) is passed through the coal seam, the provision of means so situated in proximity to the gasification zone as to impart a swirling motion to the said stream so that closer contact between the stream and coal face is obtained at the point of gasification.

2. A system for the underground gasification of coal comprising a channel extending through the coal system, an inlet pipe or shaft for supplying a gasifying medium (such as air, or air mixed with oxygen, or a mixture of steam and oxygen) to one end of the said channel, an outlet pipe or shaft at the other end of the said channel by which the effluent gas is collected, and a swirler in the said channel adjacent to the said inlet pipe for imparting a swirling motion to the stream of gasifying medium, the said swirler being in the form of fixed or rotating vanes or paddles, suitably arranged nozzles or the like.

3. A system for the underground gasification of coal substantially as hereinbefore described or substantially as illustrated in the drawing herein referred to.

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PROVISIONAL SPECIFICATION.

Improvements in or relating to the Underground Gasification of Coal.

We, NATIONAL RESEARCH DEVELOPMENT CORPORATION, a British Corporation, established by Statute, of 1, Tilney Street, London, W.1, do hereby declare the nature of this invention to be as follows:—

It is well known that it has been proposed to gasify coal seams (whether of black or brown coal or lignite) underground by the passage through suitable channels of air or mixtures of air with oxygen and/or steam, or a mixture of steam and oxygen and this process is being operated on a large scale in various parts of the world. From the results of these operations, it has become clear that in general the calorific value of the gas obtained is lower than had been anticipated, and in certain cases, it has been found that oxygen is finding its way in the elemental state through the gasification zone and is appearing in the effluent gas. The presence of such oxygen in the final gas is a clear indication that contact between the coal being gasified and gasifying medium is not as satisfactory as desirable and this is supported by the low calorific value of the gas generally obtained which

results from low gasification temperatures due to the same absence of efficient contact.

For efficient contact, each molecule of reacting gas in the gasifying medium must be brought into close proximity with the fuel constituting the walls of the passage and at the same time reacted gases in the boundary layer should be removed. Such conditions might be achieved by employing a highly turbulent state in the reacting gases i.e. a very high Reynolds number. Such a highly turbulent state, however, results in a high pressure drop and restricts the throughput. Pressure energy is wasted in small scale vorticity which is ineffective for transfer of gas from the core of the passage to the walls.

In the present invention, the desired contact is achieved by operating at Reynolds numbers, based on the effective hydraulic diameter of the gas passage, up to 15,000 i.e. broadly in the range just above streamline flow. If Reynolds numbers of this order are exceeded it will be necessary for the length/diameter ratio of the passage to be above about 500. Imposed upon the main flow is a swirling motion (or motions) arranged so that the axis of rotation is in the same direction as the major axis of the passage through the coal. Such a swirl has the following advantages.

(1) The gas molecules are caused to traverse a spiral path with the result that they are retained longer (for a given local gas velocity in a given length of passage i.e. the maximum effect is achieved for a given length to effective diameter ratio of the passage.

(2) The inevitable decay of swirl which takes place due to wall friction, lead to longitudinal pressure gradients in the air passage; these gradients lie in the same direction as the stream along the walls of the passage but against the stream at the core of the passage. The result is that the profile of velocity in the direction of the passage is more favourable than for swirl-free flow in that the velocity is high near the walls and decelerated in the core. The tendency for unreacted gas to pass untouched through the centre parts of the passage is therefore checked. Indeed this effect may be exploited where desirable to produce an actual flow reversal near the centre of the passage so that incompletely reacted products may be returned, in part, for further contact with the walls of the passage.

(3) The centrifugal gradient of pressure maintained by the swirl will prevent unreacted gas striking through at sudden enlargements of the passage area since the swirl maintains close contact of the high velocity stream with the rapidly diverging walls.

(4) The net result of these effects is that the length of passage required for effective gasification is reduced, hence total heat losses by conduction to the surrounding rock and coal are diminished and higher temperatures result in the reaction zone giving rise to gas of higher calorific value.

(5) All the advantages which the swirl has in bringing gas molecules into contact with the coal apply equally to the distribution of heat by heat transfer throughout the reaction zone.

6. The swirl designed to produce these effects may be a simple single core vortex or composed of several vortices with their axes of rotation lying in the direction of the gas stream. Such swirl patterns may be produced by suitably designed nozzle passages, mechanical paddles, etc. In the accompanying drawing one method of applying swirl is indicated. In Fig. 1 the seam A is undergoing gasification in the passage B through which a gasifying medium is passing from the inlet pipe C to the outlet pipe D. At the point E immediately adjacent to the inlet pipe is situated a swirler. This consists of the device shown in Fig. 2 i.e. a number of vanes F arranged radially in a housing G which is arranged at right angles to the flow of gas in passage B. The vanes are set at an angle to impart the necessary swirl to the gases.

Dated the 15th day of June, 1949.

F. A. WILLIAMS.

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674,082 PROVISIONAL SPECIFICATION

I SHEET *This drawing is a reproduction of the Original on a reduced scale.*

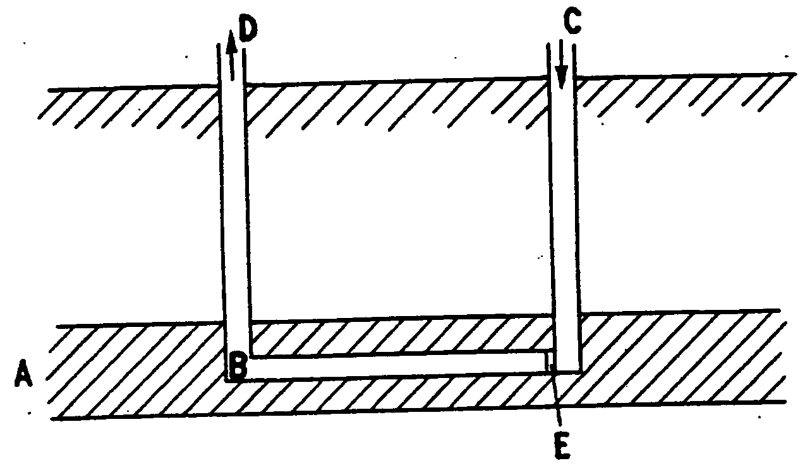

Fig. 1.

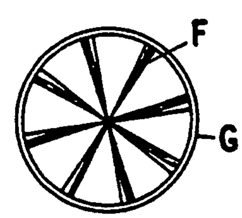

Fig. 2.